Critical Behavior of Adsorbed Fluorinated Monolayers at the Water-Hexane Interface

A. M. Tikhonov, M. Li, D. M. Mitrinovic, M. L. Schlossman (UIC)

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One of the important questions in the study of surfactants at the interface is: "What is the effect of dimensionality on the properties of the 1- and 2-dimational interfaces?" One aspect of this question involves the role of long range dipole forces in stabilizing island or stripe phases at the interface.

We used x-ray reflectivity and surface diffuse scattering measurements to study the solid to gas phase transition in soluble monolayers $F(CF_2)_{10}(CH_2)_2OH$ and $F(CF_2)_8(CH_2)_2OH$ adsorbed at the water-hexane interface. This molecule has a permanent electric dipole moment and forms a solid phase in which molecules are aligned normal to the interface. This alignment leads to an interfacial polarization, which stabilizes domains of the solid phase separated by regions of gaseous monolayer.

The figure shows a measurement of coverage vs. temperature for a monolayer of $F(CF_2)_8(CH_2)_2OH$ near the solid-gas monolayer phase transition. The line illustrates a theoretical prediction by Marchenko (see Ref. 1) that incorporates the competition of between the short and long range forces (the latter are electric dipole forces). According to this theory, the coverage is expressed as $c(T) - c(T_c) = b\ \mathrm{sign}(T_c\text{-}T)\ [\ln(T_c/|T\text{-}T_c|)]^{-\nu}$, in the limit $T \rightarrow T_c$, where b and ν are positive constants unspecified by theory. Marchenko's theory allows us to use our measured equilibrium island sizes to show that the 1-dimensional line tension for this solid domains is 10^{-9} – 10^{-10} N.

References: V.I. Marchenko, JETP, **63**, 1315 (1986)

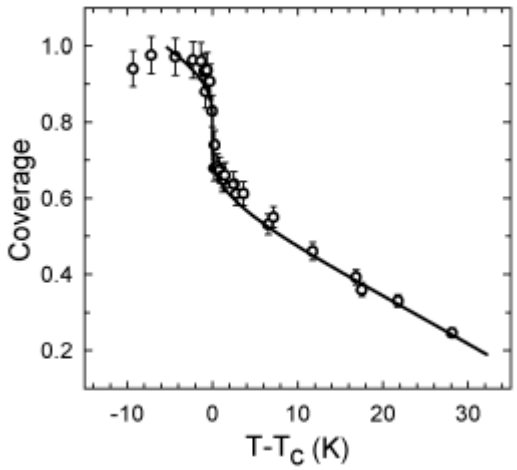

Figure 1. Coverage (fraction of the interface covered by solid monolayer domains) for a monolayer of $F(CF_2)_8(CH_2)_2OH$ at the water-hexane interface (T_c = 300.5 K).